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THESIS

ANALYSIS OF JUNIOR RESERVE OFFICER TRAINING CORPS PARTICIPATION AND ITS EFFECTS ON FIRST-TERM ATTRITION, PROMOTION, AND REENLISTMENT

by

Patrice R. Hentz
Matthew G. Packard

June 2007

Thesis Advisor: Samuel E. Buttrey
Second Reader: Lyn R. Whitaker

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13. ABSTRACT (maximum 200 words)

This study investigates whether participation in the Junior Reserve Officer Training Corps (JROTC) significantly affects U.S. Navy enlisted first-term attrition, promotion, reenlistment, time to attrition, and time to promotion. The first term of enlistment is defined as the first four years of naval service upon accession (recruitment), which are mandatory by contract. This analysis takes data from the Defense Manpower Data Center enlisted personnel service member files of U.S. Navy recruits from FY1994-2000. Each recruit has seven year's worth of data for each accession year except those from 2000, who have six. This analysis finds that JROTC has a suggestive, but not definite, statistical positive association with first-term attrition and time to promotion. Furthermore, JROTC has a statistically significant positive association with promotion, reenlistment, and time to attrition. Up to this point there has been little research conducted on the relationship between JROTC participation and propensity to succeed in enlisted naval service. This effort, coupled with LT Roy Lamont's thesis on the effects of JROTC (March 2007), could yield significant benefit in determining the return on investment of the program from the retention and performance perspective.

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Patrice R. Hentz
Ensign, United States Navy
B.S., Norfolk State University, Virginia, 2006

Matthew G. Packard
Ensign, United States Navy
B.S., United States Naval Academy, Maryland, 2006

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June 2007**

Authors: Patrice R. Hentz

Matthew G. Packard

Approved by: Samuel E. Buttrey
Thesis Advisor

Lyn R. Whitaker
Second Reader

Dr. James N. Eagle
Chairman, Operations Research Department

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ABSTRACT

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During my time here at the Naval Postgraduate School I have grown to truly learn the value of my education. This thesis is unquestionably the culmination of my educational growth here at NPS. For this success I would like to thank God first and foremost because without Him I am nothing. I would also like to thank my professors here at NPS for all that I have learned. I especially want to thank my thesis advisor and second reader, Samuel E. Buttrey and Lyn R. Whitaker for all of their time spent and knowledge shared with Matt and me. I cannot forget about my thesis partner Matthew Packard. Thanks for working hard with me to make this thesis happen. Last but certainly not least I would like to thank my Mom, Dad, Jones Family, Brian, my son Kendall, and all of my friends for all of their support and love while completing this challenging program. Oh, and a last pat on the back to myself!

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EXECUTIVE SUMMARY

This study investigates whether participation in the Junior Reserve Officer Training Corps (JROTC) significantly affects U.S. Navy enlisted first-term attrition, promotion, reenlistment, time to attrition, and time to promotion. The first term of enlistment is defined as the first four years of naval service upon accession (recruitment), which are mandatory by contract. This analysis takes data from the Defense Manpower Data Center enlisted personnel service member files of U.S. Navy recruits from FY1994-2000. Each recruit has seven year's worth of data for each accession year except those from 2000, who have six.

Continuing LT Roy Lamont's JROTC thesis (March 2007) from the NPS Business School, we examine attrition, promotion, reenlistment, time to attrition, and time to promotion rates of enlisted sailors having JROTC experience versus those who do not. We created binary variables to represent whether a recruit attrites after the first four years. Other binary response variables represented promotion to E4 or E5 and reenlistment after a four-year term. The Time to Attrite and Time to Promote variables are accounted for in number of years. We then combined all seven accession years of data into one large comprehensive JROTC data set. After importing the data into S-Plus, we fit models for all of the response variables as a function of independent variables and their interactions, including a binary variable for participation in JROTC and variables for sex, race/ethnicity, education level, AFQT mental group, entry pay grade, dependents, marital status, and age. Step-wise selection is used to select more parsimonious models. Next, each model is cross-validated to ensure that it is not over-fit. Once our final models are complete, we interpret JROTC's effect on Attrition, Promotion, Reenlistment, Time to Attrite, and Time to Promote. We also are able to view what other recruit demographics affect these important measures of performance.

This analysis finds that JROTC has a suggestive, but not definite, statistical positive association with first-term attrition and time to promotion. Furthermore, JROTC has a statistically significant positive association with promotion, reenlistment, and time

to attrition. Up to this point there has been little research conducted on the relationship between JROTC participation and propensity to succeed in enlisted naval service. This effort, coupled with LT Roy Lamont's thesis on the effects of JROTC (March 2007), could yield significant benefit in determining the return on investment of the program from the retention and performance perspective.

I. INTRODUCTION

A. BACKGROUND AND OVERVIEW OF THE JROTC PROGRAM

Junior Reserve Officer Training Corps (JROTC) is a program that has sought to promote leadership, strengthen character, and encourage citizenship since the passage of the National Defense Act of 1916. Under this Act the military is permitted to launch programs for willing citizens or permanent residents in grades eight and higher. The requirement for the schools participating is that the student enrollment in these programs must be at least 100 students per school, or 10% of the student population that is at or above the 8th grade, whichever is less. Also, under this Act, the military is approved to lend military personnel, active or reserve, to assist in teaching certified military courses.

A few of the "objectives stated by the Department of the Army that each cadet is expected to strive for include: developing good citizenship and patriotism; developing self-reliance, leadership, and responsiveness to constituted authority; improving the ability to communicate well both orally and in writing; developing an appreciation of the importance of physical fitness; increasing a respect for the role of the US Armed Forces in support of national objectives; and developing knowledge of basic military skills. As for the Department of the Navy, its version of JROTC, NJROTC, strives to instill the Navy's core values of honor, courage, and commitment in each of its participants."[1]

JROTC is funded by the United States Department of Defense (DOD). During fiscal year 2007, the United States DOD allocated $340 million dollars for JROTC programs. This is to cover costs such as instructors' pay, textbooks, equipment, and cadet uniforms. As of June 2006 the enrollment of the JROTC program is as follows: [2]

[1] Electronic Code of Federal Regulations Title 32: National Defense 542.2, http://ecfr.gpoaccess.gov/cgi/t/text/textidx?c=ecfr;sid=f1b0121929cc5ab074e1fea890753646;rgn=div8;view=text;node=32%3A3.1.1.3.18.0.13.4;idno=32;cc=ecfr.

[2] Office of the Secretary of Defense, Operation and Maintenance Overview February 2006 (FY 2007) Budget Estimates, http://www.defenselink.mil/comptroller/defbudget/fy2007/fy2007_overview.pdf.

Army (AJROTC):	1559 units[3]
Navy (NJROTC):	619 units[4]
Air Force (AFJROTC):	794 units[5]
Marine Corps (MCJROTC):	216 units[6]
Coast Guard (JROTC):	1 unit[7]

Approximately "40% of NJROTC graduates enter military service. Minority participation is 64%: 34% African-American, 22% Hispanic, 4% Asian American/Pacific Islander, 1% Native American/Alaskan Native, and 3% Other. Approximately 58% of all NJROTC graduates continue on to post-secondary education (including ROTC programs and military academies)."[8]

1. History

One of the biggest advantages of JROTC when it was first formed around 1916 was that a cadet could receive a certificate of eligibility for a reserve commission at the age of 21. The only requirement for this was that the student needed to complete three hours of military instruction per week for three years. When the need for reserve officers declined after World War I, the promise of a reserve commission was allowed to disappear along with the demand.

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[3] United States Army Junior Reserve Officers' Training Corps Directorate, https://www.usarmyjrotc.com/jrotc/dt/2_History/history.html.

[4] Naval Service Training Command , Naval Reserve Officers' Training Corps, https://www.njrotc.navy.mil/basicfacts.cfm.

[5] Air Force Officer Accession and Training Schools, "AFJROTC History," http://www.afoats.af.mil/AFJROTC/history.asp.

[6] United States Marine Corps, http://www.mcjrotc.org/about/history.aspx.

[7] Edward J Kruska, *Coast Guard Prep*, http://www.uscg.mil/reservist/mag2003/JulAug03/MAST.htm.

[8] Naval Service Training Command, "NJROTC Basic Facts," https://www.njrotc.navy.mil/basicfacts.cfm.

During the years 1916 - 1919, the Army established JROTC units at 30 secondary schools. Around 45,000 students were enrolled in JROTC during the 1919-1920 school years. During these years the only service in the Department of Defense that supported JROTC programs was the Army. The other services formed their own JROTC units at a later date. On October 13, 1963, President John F. Kennedy signed Public Law 88-647, the ROTC Vitalization Act of 1964. It required the services to increase the number of JROTC units and to achieve a more homogeneous geographical distribution of units across the nation. Specifically, Public Law 88-647 required that the Secretary of each military department shall establish and maintain a Junior ROTC, organized into units, at public and private secondary educational institutions which apply for a unit and meet the standards and criteria prescribed in accordance to this section. Also, "no more than 200 units may be established by all of the military departments each year beginning with calendar year 1966, and the total number of units that may be established on the date of enactment in this section may not exceed 1,200. The President shall promulgate regulations prescribing the standards and criteria to be followed by the military departments in selecting the institutions at which units are to be established and maintained and shall provide for the fair and equitable distribution of such units throughout the Nation, except that more than one unit may be established and maintained at any military institute."[9] For instance, the Navy's NJROTC was established in 1964, and the program is now conducted at secondary schools throughout the nation.

On August 24, 1992, Congress expanded the JROTC program to 3,500 units. This increase in number was directly influenced by General Colin Powell. He was the primary supporter of expanding the program because of two major events: the recent Los Angeles riots and the recent victory in Operation Desert Storm. He believed that the riots emphasized the need for opportunities and programs for teenagers in economically disadvantaged areas. He decided that since the recent victory of Operation Desert Storm, the American people were proud of the United States military and this was an opportune time to provide youth with opportunities in the military through JROTC.

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[9] United States Marine Corps JROTC History, http://www.mcjrotc.org/about/history.aspx.

B. OBJECTIVES

What percentage of return are the Navy, and other Armed services, receiving from these investments? Despite the fact that the JROTC program is not designed to be a recruiting tool for the Armed Forces, it is not far-fetched that the military should expect some type of gain in the number of enlisted recruits or even an expansion of numbers in officer programs. Might indeed the expectation of a JROTC participant's performance be higher than that of a non-JROTC participant? How is the Navy benefiting from this? Is the JROTC program producing a significant number of recruits into the Armed Forces? Do JROTC participants perform at a higher standard than those of non-participants? And, even further, are their times to attrite or times to promote different than those of other sources? These are the questions we seek to answer or illuminate.

C. OUTLINE

In Chapter II, we discuss the definitions of our dependent response variables of Attrition, Promotion, Reenlistment, Time to Attrite, and Time to Promote. The percentage of non-promoters will also be defined. Chapter III explores the data by commenting on its modifications prior to analysis and by defining the dependent and independent variables. Chapter IV describes the models and methodology of our analysis by fitting base models and examining diagnostics and variable selection. Finally, Chapter V discusses model cross-validation, conclusions, and recommendations for future study.

II. DEFINITIONS OF MEASURES OF EFFECTIVENESS

A. INTRODUCTION

To capture the potential effects of JROTC, we consider five measures of effectiveness. These five measures play the role of dependent variables in subsequent analysis. They are Attrition, Promotion, Reenlistment, Time to Attrite, and Time to Promote. This chapter defines each of these measures carefully and provides some preliminary summary statistics on these measures.

B. ATTRITION

Attrition is defined as the rate at which something decreases in numbers, size, or strength. Attrition in the number of active duty personnel is an issue that the military has always had to address; therefore it is imperative that we include this in our model. The service member may attrite due to a positive voluntary reason, such as entry into an officer program, or due to a negative involuntary reason such as testing positive for drugs. There is a wide range of reasons for which attrition may occur.

1. Process

We created a binary "attrite" variable for each service member in our data to indicate if the service member attrited in the first, second, or third year. Although we have data on each service member for seven years, it is only necessary to record attrition for the first four years, which represents one full term served. Since the first term of a recruit is four years, those who leave the Navy in the fourth year are considered having completed their term and thus not counted towards attrition. Individuals who did not have information in their file for all four years of their first term were classified as "attrite."

C. PROMOTION

1. Restrictions

In the Navy there are specific manpower quotas to fill in each rank and rate. These quotas are determined by Congress. Congress tells the Navy how many enlisted personnel may be on active duty at any time. Promotions are controlled by the specific demands of each rank and rate. It is important to note that most individuals who participated in three or four years of JROTC enter the Navy at the rate of E3 (seaman) because of their military experience and training in high school. The Navy takes its total number of enlisted personnel in a certain rate and partitions those numbers down by rating. For example there may be 3000 SK's (Store Keeper) at any point in time and only 10% of them may be E4's. In order to promote a service member (above the rank of E-3), there must be a "vacancy." For example, if an E-5 leaves the Navy in a certain rating, then one E-4 may be promoted to E-5, and that promotion opens an E-4 slot, so one E-3 may be promoted to E-4, and so forth. If 200 E-5s leave the Navy in a particular rating, then 200 E-4s may be promoted to E-5 in that specific rating. The Navy currently has 323,745 enlisted members on active duty.[10]

2. Statistics

The current number and percentages of enlisted personnel are as follows:[11]

Table 1. Numbers of Current Enlisted Personnel (FY2007) by Rate

Rate	Current number	Percentage
Seaman Recruit (E-1)	17,516	5.4%
Seaman Apprentice (E-2)	24,648	7.6%
Seaman (E-3)	55,067	17.0%

[10] Rod Powers, "Enlisted Promotions Made Simple," http://usmilitary.about.com/cs/navypromotions/a/navypromotion.htm.

[11] Ibid.

Petty Officer Third Class (E-4)	67,111	20.7%
Petty Officer Second Class (E-5)	73,099	22.6%
Petty Officer First Class (E-6)	52,800	16.3%
Chief Petty Officer (E-7)	23,715	7.3%
Senior Chief Petty Officer (E-8)	6,610	2.0%
Master Chief Petty Officer (E-9)	3,179	1.0%

D. REENLISTMENT

Reenlistment is defined as when a sailor successfully completes one four-year term in the Navy and signs another contract of variable length to continue serving in the Navy. This is usually accompanied by some type of monetary bonus. Successful completion is attained if a sailor completes four years in the Navy without being asked, or told, to leave the service for any reason.

E. TIME TO ATTRITE

Time to Attrite is measured by the number of years a service member continues to stay in the service before leaving the Navy due to attrition. Time to attrite is not computed for service members who leave the service upon the completion of a full term of enlistment. This variable is a numeric variable. We compute this variable by first conditioning on whether the service member did or did not attrite. Next, to calculate the number of months the member served, we subtract their Date of Separation (DOS) from their Pay Entry Base Date (PEBD). This gives the number of months each individual was recorded to have served in the Navy. Time to Attrite in months is converted to years by rounding up to the nearest year. For example, if an individual enlisted and was only in the service for three months, then we recorded their Time to Attrite as one year. Even though we can track a member by the number of months they served, we record their time by years in order to stay consistent with Time to Promote.

F. TIME TO PROMOTE

Time to Promote, which is also numeric, is computed similarly to Time to Attrite. In order to compute a time to promote, the individual must first be promoted. We track those individuals' dates of promotion to their next rate, but only if that rate is E4 or E5. When that date is found, we find the difference in time between it and the date they entered into the Navy measured by their PEBD.

Not all sailors are promoted to E4 or E5 in a four-year term, either due to attrition, no vacancies being available for their rate, or poor performance. We must account for the number of recruits who do not promote during their first term. Sailors who are not promoted in the first term have a zero recorded in their Time to Attrite field and are classified as non-promotes. Because instantaneous promotion can never occur in the four-year time frame, a time to promote is not computed for non-promotes and hence they contribute nothing when computing average times to promote. For those service members who are promoted in their first term, Time to Promote takes a value of 1, 2, 3, or 4. Non-promotes contribute nothing when averaging overall Times to Promote because they never promote. Therefore, the range of years it takes someone to promote is from zero to four as a numerical variable for this model.

III. DATA EXPLORATION

A. INTRODUCTION

Data Exploration is an essential first step in analyzing our data. Doing this not only gives us an idea of how the data was collected, but it also makes us aware of the challenges that may arise when making sense of the data. To be certain we create logical models, we must first know what the data is telling us.

B. INSPECTION

The data received from the Defense Manpower Data Center (DMDC) consists of seven large Excel files that contain information on each individual that enlisted in the Navy during the fiscal years of 1994-2000. These files contain specific, requested variables, such as social security numbers (scrambled to preserve the privacy of the service members), basic demographics, and whether they participated in a youth program such as JROTC. Additional variables include the entry rate of the individual, Armed Forces Qualification Test (AFQT) scores, and AFQT Mental Group categories. The data is arranged in the Excel spreadsheet with one service member per row and his or her respective demographics arranged in columns. Once this information is complete, the next seven years contain all information that is updatable along with each respective year. Variables such as marital status, age, rate, dependents, and education level are among the pieces of information that can continue to change over the seven-year period.

1. First Steps

Inconsistencies in the data occur for several variables. For instance, for the PEBD year variable for the year of 1994, there should only be a 93 or 94 indicating the year that individual's PEBD started. However, values such as zero were found, indicating what can be assumed to be the year 2000, or a 90 indicating the year 1990. The FY1994 file is only meant to contain personnel who entered the system in the fiscal year of 1994.

Another interesting inconsistency noticed in the data is that PEBD and DOS months for many individuals were listed as values of zero.

Gaps in the data are to be expected because every individual has served a different amount of time in the Navy. Therefore, they are not expected to all have the same amount of information.

2. S-Plus Modifications

Many modifications needed to be made to the data in order to create the models. We decided to have one comprehensive data set, which includes all seven fiscal years of data, instead of working on seven separate data sets. Therefore, the fitted models are based on all the data available.

A problem encountered with the arrangement of the data in the comprehensive data set was that once a service member leaves the Navy during his first year, his or her information is not available in the variables reserved for annual updates. Variables such as education level, rate, dependents, marital status, and age, that are updated each year, contain blanks when a service member attrites or voluntarily leaves the Navy during his first year. Blanks can cause problems when creating models and performing calculations. Therefore, we omitted any record of the data set that contained missing values in the first year. After this operation was applied to the comprehensive JROTC data set, 50,290 observations out of a total of 308,367 observations were deleted. The updated comprehensive data set now contained 258,077 observations and only includes these service members who completed at least their first year of enlistment.

Our analysis was performed in the program S-Plus.[12] We also used the "Mass" library included in S-Plus for step-wise selection and used the function xval[13] for cross-validation. The xval function takes a fitted model and cross-validates it with the data originally used. This is done by generating a permutation of the numbers from 1 to the number of observations. Then it partitions the data into n (default: 10) parts and uses the

[12] Insightful Corporation, *S-Plus 7.0 Help Manual*, 2005.

[13] Samuel E. Buttrey, S-PLUS xval function code.

"subset=" argument to run the model n times with each part left out in turn. It accumulates the residual sums of squares (RSS) from each of these n models and reports the total.[14] While running the xval function, problems arose in the RSS computations because the categorical independent variables had too many levels. To fix this problem, we reduced the number of levels in some of our categorical variables and updated our comprehensive data set to use with our models. Once the categorical variables were collapsed, our xval function was operable.

C. DATA DESCRIPTION

1. Data Modifications

The first modification to the data that was made for each service member was to create a binary variable to identify if the member was a JROTC participant or not.

2. Dependent Variables

We are concerned with five primary dependent variables for this data set. These variables are Attrition, Promotion, Reenlistment, Time to Attrite, and Time to Promote.

Table 2. Dependent variable descriptions

DEPENDENT VARIABLES	**Definition**
Attrite Year 1	1 if recruit attrited in year 1, 0 otherwise
Attrite Year 2	1 if recruit attrited in year 2, 0 otherwise
Attrite Year 3	1 if recruit attrited in year 3, 0 otherwise
Attrite Year 4	1 if recruit attrited in year 4, 0 otherwise
First-term Attrition	1 if recruit attrited in the first term, 0 otherwise
Promotion to E4 or E5	1 if recruit advanced to E4 or E5, 0 otherwise

[14] Samuel E. Buttrey, S-PLUS xval function code.

Reenlistment	1 if recruit reenlisted at end of first term, 0 otherwise
Time to Attrite (in years)	Number of years until recruit attrition
Time to Promote (in years)	Number of years until recruit promotion

3. Independent Variables

Independent variables in the data set include a wide range of personal and data demographics. Some variables were recorded for all recruits upon accession. These variables include SSN, PEDB Year and Month, DOS Year and Month, Separation Program Designator (SPD), Youth Programs, JROTC, Race, Ethnicity, Race/Ethnicity, AFQT Mental Group, Sex, AFQT Score, and Home of Record (HOR) State and Zip Code. The JROTC variable was created to identify if a recruit participated in any service branch of JROTC for a period of either three or four years. This variable was derived from the Youth Programs variable. The remaining independent variables were recorded for each year of service for up to seven years. These recurring annual variables include Pay Grade, Drop on Request (DOR) Date, Duty Country and Station, Years of Service, Rate, Age, Number of Dependents, Marital Status, Education Level, Place of Birth (POB) Country and State, Months in Pay Grade, Type of Collocated Dependents, Number of Collocated Dependents, Involuntary Retention Code, Enlisted Active Service Agreement Duration in Years, Enlisted Active Service Projected End Calendar Date, Enlisted Career Status Code, Accession Service of Accession Code, and Educational Discipline Code.

Since there are many variables in the data set and several that contained either no data or faulty data, the following nine variables in the table below are the independent variables chosen for analysis.

Table 3. Independent variable descriptions

INDEPENDENT VARIABLES	**Definition**
JROTC (categorical)	1 if recruit participated in 3 or 4 years of JROTC in high school, 0 otherwise
Sex (categorical)	"M" = male, "F" = female
Race/Ethnicity (categorical)	"A" = American Indian, "B" = Asian or Pacific Islander, "C" = African-American, "D" = Caucasian, "E" = Hispanic, "X" = Other, "Z" = Unknown
EducationLevel (categorical)	"None" = missing values, "<HS" = Education below high school, "Curr" = Currently in high school, "HS" = High school graduate or GED certificate, "C2" = Currently in college (Associate or Bachelor degree program), "Coll+" = Bachelor degree or postgraduate degree, "Unk" = Unknown
AFQT Mental Group (categorical)	"CAT1" = 93^{rd}-99^{th} percentile, "CAT2" = 65^{th}-92^{nd} percentile, "CAT3A" = 50^{th} – 64^{th} percentile, "CAT3B" = 31^{st} – 49^{th} percentile, "Fail" = 30^{th} percentile and below, "Unk" = Unknown
PayGrade (categorical)	"E01" = E1, "E02" = E2, "E03" = E3, "E04" = E4, "E05+" = E5-E8 & O1-O3, "Unk" = Unknown & 'E00'
Dependents (numeric)	Number of recruit's dependents
MaritalStatus (categorical)	"M" = Married, "N" = Not married
Age (numeric)	Current age of recruit

D. PRELIMINARY STATISTICS

The key independent variable in the data set is the binary JROTC variable. The following tables illustrate several key descriptive statistics in the data set. All recruits from accession FY1994-2000 in the data set are partitioned into JROTC and Non-JROTC recruits. In total, there are 308,367 recruits in the original Excel data files. This forms the basis of the following tables. Note that these tables are derived from the Excel files (308,367 observations), not the comprehensive data set (258,077 observations) that is used for the models in Chapters IV and V. Table 3 depicts the ratio of JROTC to Non-JROTC in each accession year.

Table 4. Ratio of JROTC and Non-JROTC by Year

YEARS	JROTC	Non-JROTC	Total
FY1994	1081	35318	36399
FY1995	1111	36534	37645
FY1996	1127	39684	40811
FY1997	1319	44806	46125
FY1998	1338	43600	44938
FY1999	1262	49920	51182
FY2000	1170	50097	51267
Total	8408	299959	308367

Note that over the years JROTC participation steadily increased until 1998, where it steadily decreased. The proportion of JROTC participants in relation to all recruits has gradually dropped from 3% to 2%. Figure 1 illustrates the data set's overall ratio between JROTC recruits and Non-JROTC recruits. In total, JROTC participants account for 3% of all Navy recruits from FY1994-2000.

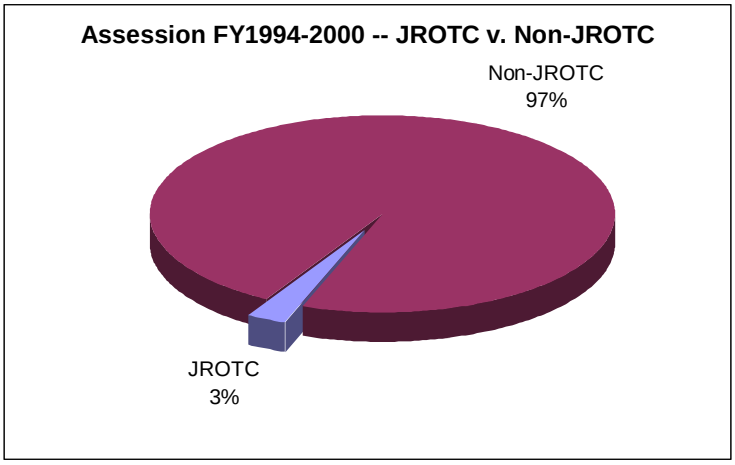

Figure 1. FY1994-2000 JROTC v. Non-JROTC

The remaining tables compare several key demographics to JROTC and Non-JROTC recruits over FY1994-2000 time period. Table 5 compares the distribution of gender for the two categories. Males make up the largest percentage of service members in both JROTC and Non-JROTC categories, while a larger percentage of females are JROTC members than are Non-JROTC members, by about 4%.

Table 5. Distribution of Gender by JROTC and Non-JROTC

GENDER	JROTC	Non-JROTC
Male	68.11%	69.91%
Female	18.13%	13.71%
Unknown	13.76%	16.38%

Table 6 presents the partition of JROTC and Non-JROTC by race and ethnicity. While whites represent the largest racial group in the Non-JROTC category, minorities comprise about 57% of JROTC recruits and only approximately 48% of Non-JROTC recruits. This point will become an important factor in analysis later in Chapter IV in the Attrition model.

Table 6. Distribution of Race/Ethnicity by JROTC and Non-JROTC

RACE/ETHNICITY	JROTC	Non-JROTC
White	42.92%	52.09%
Black	31.52%	15.29%
Hispanic	6.91%	9.42%
Asian	2.63%	3.95%
American Indian	1.59%	2.25%
Other	0.27%	0.32%
Unknown	14.15%	16.68%

Table 7 shows education levels, ranging from no high school diploma or GED certificate to postgraduate degrees. It must be noted that about 74% of JROTC recruits received a high school diploma or GED certificate, while only about 69% of Non-JROTC recruits did the same.

Table 7. Distribution of Education by JROTC and Non-JROTC

EDUCATION	JROTC	Non-JROTC
Non HS grad/GED	5.11%	7.48%
HS grad/GED	74.30%	68.50%
Some college	1.43%	2.35%
College degree	0.34%	1.12%
Post college degree	0.04%	0.05%
No Ed info	18.78%	20.51%

Table 8 illustrates the partition of AFQT percentiles and scores between the two groups. Individuals require a waiver to enlist in the military with an AFQT category (CAT) below CATIIIB. This explains why very few recruits were in CATIV or CATV mental groups. CATI includes the recruits who scored in the 93^{rd}-99^{th} percentile, while CATII includes those who scored in the 65^{th}-92^{nd} percentile. CATIIIA includes those who scored in the 50^{th}-64^{th} percentile, while CATIIIB includes those individuals who scored in the 31^{st}-49^{th} percentile.[15] Note that overall, JROTC recruits tend to score lower on the AFQT than Non-JROTC recruits. However, the actual AFQT average scores are about the same.

[15] Roy A. Lamont, "The Impact of Junior Reserve Officer Training Corps and Other Youth Programs on Navy First Term Attrition, Promotion, and Reenlistment," M.S. thesis, Naval Postgraduate School, March 2007.

Table 8. Distribution of CAT group/AFQT scores by JROTC and Non-JROTC

CAT GROUP/AFQT SCORE	JROTC	Non-JROTC
CAT missing	0.88%	2.23%
CATV	0.00%	0.00%
CATIVC	0.02%	0.00%
CATIVB	0.00%	0.01%
CATIVA	0.12%	0.08%
CATIIIB	36.05%	29.81%
CATIIIA	26.90%	25.31%
CATII	32.43%	37.20%
CATI	3.59%	5.37%
AFQT average	47.3	47.8

Table 9 depicts the partition of entry pay grade for both types of recruits. As was mentioned in Chapter II, most JROTC participants enter the Navy at the rate of E3. About 61% of JROTC recruits enter the Navy at E3, while most Non-JROTC recruits (about 62%) enter the Navy at E1 or E2. The only way a recruit with no JROTC experience can enter the Navy at a rate higher than E1 is to either refer friends to the Navy recruiter, complete some college credits, or earn a college degree prior to enlisting.

Table 9. Distribution of Entry Pay Grade by JROTC and Non-JROTC

ENTRY PAY GRADE (YEAR 1)	JROTC	Non-JROTC
E1	7.39%	35.11%
E2	14.75%	26.90%
E3	61.01%	16.17%
E4	2.87%	4.40%
E5 and above	0.15%	0.71%
Unknown	13.83%	16.71%

Table 10 summarizes the performance of JROTC and Non-JROTC recruits based on the key demographics covered in Tables 3-8 from FY1994-2000. Table 10 presents percentages based on variable averages, or in other words, on the dependent variables of First-term Attrition, Promotion, Reenlistment, Time to Attrite, and Time to Promote. The vast majority of attrites, promoted recruits, and reenlisted recruits are Non-JROTC, but

this is because there are far more Non-JROTC than JROTC recruits. Table 11 will better show these statistics using percentages based on JROTC and demographics (rows), not performance (columns).

Table 10. Percentages based on Variable averages

	First-Term Attrition	Promotion to E4 or E5	Reenlistment	Time to Attrite	Time to Promote if promoted	Non-promotes
JROTC	2.51%	2.88%	3.00%	2.69	2.89	2.55%
Non-JROTC	97.49%	97.12%	97.00%	2.88	2.96	97.45%
Male	49.37%	85.05%	83.25%	3.19	2.93	52.72%
Female	10.40%	14.83%	16.46%	3.30	3.13	12.71%
Unknown	40.23%	0.13%	0.29%	1.14	3.22	34.57%
White	38.56%	63.88%	59.43%	3.28	2.87	38.25%
Black	11.68%	15.97%	19.24%	3.05	3.16	15.46%
Hispanic	5.70%	11.28%	11.65%	3.10	3.15	7.18%
Asian	1.68%	5.24%	5.97%	2.84	3.06	2.41%
American Indian	1.76%	2.68%	2.60%	3.15	2.95	1.73%
Other	0.20%	0.38%	0.40%	3.34	2.95	0.24%
Unknown	40.41%	0.57%	0.71%	1.22	2.47	34.73%
Non HS grad/GED	7.62%	7.26%	7.13%	3.01	3.12	7.58%
HS grad/GED	46.07%	83.85%	83.79%	3.20	2.99	51.50%
Some college	1.99%	2.67%	2.58%	3.12	2.79	1.94%
College degree	0.58%	1.67%	1.59%	3.50	2.38	0.45%
Post college degree	0.04%	0.06%	0.07%	3.00	2.33	0.05%
No Ed info	43.70%	4.50%	4.83%	1.48	2.84	38.47%
CAT missing	1.60%	3.40%	2.80%	6.43	1.49	0.84%
CATV	0.00%	0.00%	0.00%	N/A	N/A	0.00%
CATIVC	0.00%	0.00%	0.00%	N/A	N/A	0.00%
CATIVB	0.00%	0.00%	0.01%	N/A	N/A	0.00%
CATIVA	0.08%	0.08%	0.08%	4.34	N/A	0.07%
CATIIIB	32.16%	23.35%	26.27%	2.61	3.47	37.46%
CATIIIA	26.78%	22.87%	23.16%	2.72	3.31	28.15%
CATII	34.86%	42.82%	40.65%	2.86	2.80	30.57%
CATI	4.52%	7.47%	7.02%	3.15	2.10	2.90%
E1	25.99%	32.02%	36.26%	2.88	3.68	36.97%
E2	20.25%	32.60%	30.65%	3.07	3.09	19.77%
E3	10.63%	25.59%	24.28%	3.39	2.61	8.14%
E4	2.43%	8.22%	6.94%	5.19	1.00	0.00%
E5 and above	0.24%	1.03%	1.23%	5.91	0.70	0.32%
Unknown	40.47%	0.54%	0.63%	1.16	3.19	34.80%

Table 11 is similar to Table 10, but with the difference that averages are computed by rows, or demographics. This table reveals that the JROTC recruits' attrition rate is about 3% lower than Non-JROTC recruits' attrition rate. Also, JROTC promotion rate is roughly 3% higher than Non-JROTC, while the JROTC reenlistment rate is also higher than Non-JROTC by about 4%. However, time to attrite is slightly lower for JROTC than Non-JROTC. This could be due to the fact that the data in Table 11 does not account for individuals who attrite in the first year of enlistment. On the other hand, time to promote is lower for JROTC than Non-JROTC, which is a preferred result. This shorter time till promotion to E4 or E5 may be due to the fact that most JROTC participants enter the Navy at E3. Therefore, it takes them less time to reach E4 or E5 than their Non-JROTC counterparts. Finally, JROTC recruits have fewer non-promotes than Non-JROTC, by about 3%.

Table 11. Percentages based on Row averages

	First-Term Attrition	Promotion to E4 or E5	Reenlistment	Time to Attrite	Time to Promote if promoted	Non-promotes
JROTC	37.06%	56.05%	46.73%	2.69	2.89	43.95%
Non-JROTC	40.38%	52.94%	42.29%	2.88	2.96	47.06%
Male	28.47%	64.55%	50.54%	3.19	2.93	35.45%
Female	30.30%	56.84%	50.49%	3.30	3.13	43.16%
Unknown	99.40%	0.42%	0.75%	1.14	3.22	99.58%
White	29.97%	65.34%	48.62%	3.28	2.87	34.66%
Black	29.92%	53.83%	51.88%	3.05	3.16	46.17%
Hispanic	24.54%	63.95%	52.83%	3.10	3.15	36.05%
Asian	17.36%	71.06%	64.73%	2.84	3.06	28.94%
American Indian	31.77%	63.68%	49.27%	3.15	2.95	36.32%
Other	25.82%	63.79%	54.32%	3.34	2.95	36.21%
Unknown	98.01%	1.81%	1.82%	1.22	2.47	98.19%
Non HS grad/GED	41.39%	51.94%	40.81%	3.01	3.12	48.06%
HS grad/GED	27.04%	64.76%	51.76%	3.20	2.99	35.24%
Some college	34.52%	60.86%	47.19%	3.12	2.79	39.14%
College degree	21.43%	80.55%	61.54%	3.50	2.38	19.45%
Post college degree	30.91%	55.15%	56.97%	3.00	2.33	44.85%
No Ed info	86.06%	11.66%	10.02%	1.48	2.84	88.34%
CAT missing	29.37%	82.08%	54.15%	6.43	1.49	17.92%
CATV	0.00%	0.00%	100.00%	N/A	N/A	100.00%

CATIVC	45.45%	63.64%	45.45%	N/A	N/A	36.36%
CATIVB	40.00%	53.33%	46.67%	N/A	N/A	46.67%
CATIVA	40.25%	55.93%	45.34%	4.34	N/A	44.07%
CATIIIB	43.22%	41.30%	37.17%	2.61	3.47	58.70%
CATIIIA	42.56%	47.83%	38.75%	2.72	3.31	52.17%
CATII	37.90%	61.26%	46.52%	2.86	2.80	38.74%
CATI	34.19%	74.44%	55.95%	3.15	2.10	25.56%
E1	30.48%	49.43%	44.77%	2.88	3.68	50.57%
E2	30.71%	65.05%	48.93%	3.07	3.09	34.95%
E3	24.63%	78.02%	59.20%	3.39	2.61	21.98%
E4	22.43%	100.00%	67.60%	5.19	1.00	0.00%
E5 and above	13.68%	78.46%	75.06%	5.91	0.70	21.54%
Unknown	98.03%	1.73%	1.61%	1.16	3.19	98.27%

Table 12, the final table in this section, shows the partition of all recruits by pay grade in FY1994-2000 upon reaching the end of their first term of enlistment in year 4. While only about 1% of all recruits in FY1994-2000 stayed at the rates of E1 and E2, 59% advanced to the rate of E3 or higher. The remaining 40% of recruits are considered "unknown" because they left the Navy voluntarily or not after their first term of enlistment.

Table 12. Distribution of Pay Grade Percentages at Year 4

Pay Grade	% at Year 4
E1	0.50%
E2	0.60%
E3	10.54%
E4	36.60%
E5 and above	11.86%
Unknown	39.90%

IV. MODELS AND METHODOLOGY

A. FITTING THE MODELS

1. Base Models

We first fit five models: one for each of Attrition, Promotion, Reenlistment, Time to Attrite, and Time to Promote. The Attrition, Promotion, and Reenlistment models are logistic regression models because the response (dependent) variables are binary. On the other hand, the Time to Attrite and Time to Promote models are linear regression models because their response variables are numeric. These models include nine independent variables, seven of which are categorical and two numerical. Some of the variables from the original data set were excluded. For example, AFQT score was excluded because the categorical variable AFQT Mental Group is used. Other variables not included were the separate variables of Race and Ethnicity. Instead, we use the Race/Ethnicity variable that captured what the two separate variables were recording as one variable. The last variables that were not included in these models were the variables that recorded each recruit's date of separation (DOS), pay entry based date (PEBD), home of record, rating, and duty state.

The two numeric variables included in all of the models are Dependents and Age. The seven categorical variables included in the model are the three binary variables JROTC, Sex, and Marital Status and the four categorical variables Race/Ethnicity (with seven levels: American Indian, Asian or Pacific Islander, African-American, Caucasian, Hispanic, Other, and Unknown), Education Level (with six levels: Education below high school, currently in high school, high school graduate or GED certificate, currently in college (Associate or Bachelor degree program), Bachelor degree or postgraduate degree, and Unknown), AFQT Mental Group (with six levels: CAT1, CAT2, CAT3A, CAT3B, Fail, and Unknown), and Entry Pay Grade (with six levels: E01, E02, E03, E04, E05+, and Unknown). In each of the models, categorical variables with l levels are replaced by l-1 binary variables.

B. DIAGNOSTICS

Diagnostics were performed after fitting the additive models described in the previous section. Diagnostics include analyzing residual versus fitted plots, residual Quantile Quantile (QQ) normal plots, and partial residual plots. Because most of the independent variables (predictors) are categorical, partial residual plots will be left out of our analysis. These plots indicate that the assumption of equal variance is reasonable for the linear regression fits. They also confirmed that transformations on polynomial terms are not needed for the two numeric independent variables. Further, Cook's Distances computed for all five models did not reveal any unduly influential observations.

C. VARIABLE SELECTION

We now perform variable selection on each model so that we can add any needed interactions or possibly eliminate any variables that are not needed.

1. Attrition

Generally, interaction implies that the effect (on the dependent variable) produced by changing one variable (say, JROTC) depends on the level of another variable (say, Race/Ethnicity). "Interactions occur frequently in the study and analysis of real-world systems, and regression methods are one of the techniques that we can use to describe them."[16] To test for interactions in the first model of Attrition, we used a step-wise selection procedure implemented with a custom S-Plus function written by our advisor, Samuel E. Buttrey. This function takes a model and compiles all of the possible interactions and calculates each one's Akaike Information Criterion (AIC),[17] residual deviance, degrees of freedom, Chi-squared p-value, and arranges them in order of their residual deviance. In this case, it took the 1994 Attrition model which is exactly the same model as the Attrition model but uses the 1994 data set instead of the comprehensive data set. We had to use the 1994 Attrition model because S-Plus had dynamic memory

[16] Douglass C. Montgomery, Elizabeth A. Peck, and G. Geoffrey Vining, *Introduction to Linear Regression Analysis* (New Jersey: John Wiley & Sons, Inc., 2006), 65.

[17] Ibid.

problems calculating the large Attrition model. This custom function gives us the fit of 36 models. There are 36 combinations because we have nine independent variables and are only looking at two-way interactions. Therefore we have 9 choose 2 combinations, giving 36 different combinations. Next, we choose the models with the lowest AIC numbers and pick those interactions to explore and add to the model.

We also used step-wise selection on the additive model discussed in the previous section to see which variables (main effects) are not needed. We used the S-Plus function stepAIC. StepAIC is a function that performs stepwise variable selection by exact AIC.[18] Once we ran stepAIC, we saw that JROTC was the first variable taken out of the model. It was surprising for the results to show that JROTC would have no effect on the Attrition model in the presence of the rest of the independent variables.

We ran a few more tests on this model to deduce if JROTC was truly insignificant. These findings were suggestive in that there is some confounding between Race/Ethnicity and JROTC. First, we modeled JROTC by Sex and Race/Ethnicity to see the effects of Sex and Race/Ethnicity on JROTC participation. We discovered Sex and Race/Ethnicity were both major contributing factors when modeling JROTC. Next we looked at the numbers of JROTC white participants versus JROTC non-white participants and also Non-JROTC white participants versus Non-JROTC non-white participants. We put these numbers in Table 13 to find if there was a statistically significant difference between Race/Ethnicity and JROTC participation, which there was. We observed that non-white recruits tend to do better than white recruits. Non-white recruits that participated in JROTC also tended to do better than white recruits that participated in JROTC. Confounding variables are two variables whose effects on a response variable cannot be distinguished from each other. Also observed is that JROTC whites tended to do better than Non-JROTC whites and JROTC Non-whites tended to do better than Non-JROTC Non-whites. Although confounding is present between JROTC and Race/Ethnicity, JROTC does have a slight effect on First-term Attrition, as does Race/Ethnicity. We now have our final model.

[18] Insightful Corporation, *S-Plus 7.0 Help Manual,* 2005.

Table 13. JROTC v. Non-JROTC Attrition Rates by Race

JROTC			
	Non-attrites	Attrites	Attrition Rate
Non-white	2703	939	25.78%
White	2580	1029	28.51%
Non-JROTC			
	Non-attrites	Attrites	Attrition Rate
Non-white	69164	25408	26.87%
White	109367	46887	30.01%

Note: 50,290 observations with missing values in S-Plus were deleted, resulting in 258,077 observations.

2. Promotion and Reenlistment

We took the same approach for our Promotion and Reenlistment models as we did for our Attrition model. We started by looking for interactions in the two models by using the custom function once again, but with the appropriate 1994 Promotion and 1994 Reenlistment models. We calculated the interactions from the ANOVAs and picked the most significant interactions. Next we used stepAIC on both base models. This time JROTC was not taken out of either model; therefore, we did not have to investigate any suspicions of confounding. After using stepAIC, we had our final models of Promotion and Reenlistment.

3. Time to Attrite and Time to Promote

As stated earlier, the Time to Attrite and Time to Promote models are different than the other three models in that these two response variables are not binary. We had technical problems finding interactions, so we used our intuition to pick two out of the 36 combinations that would have the most effect on each of these models. We then took the respective base models of each and put them into the stepAIC function using the optional argument “scope,” which defines the range of models examined in the stepwise search in order to add possible interactions. We then ran stepAIC to determine what was eliminated for the final models.

V. RESULTS AND CONCLUSION

A. VALIDATION

1. Final Models

After performing all necessary data exploration and modification, fitting the five base models, diagnostics, and variable selection, we arrived at the following final models for First-term Attrition, Promotion to E4 or E5, Reenlistment, Time to Attrite, and Time to Promote. In the five regression equations below, any interaction terms were simplified to the two variable names, as opposed to naming each categorical level between the two variables, in order to make the equations more readable and to save space. The S-Plus final models contain all interaction categorical levels, which are not shown below:

First-term Attrition Model:

Ln(Pr(First-term Attrition = 1)/1-Pr(First-term Attrition = 1)) = β_0 + β_1(Sex) + β_2(American Indian) + β_3(Asian or Pacific Islander) + β_4(African-American) + β_5(Caucasian) + β_6(Hispanic) + β_7(Other) + β_8(Unknown) + β_9(Education below high school) + β_{10}(Currently in high school) + β_{11}(High school graduate or GED certificate) + β_{12}(Currently in college (Associate or Bachelor degree)) + β_{13}(Bachelor degree or postgraduate degree) + β_{14}(Unknown) + β_{15}(CAT1) + β_{16}(CAT2) + β_{17}(CAT3A) + β_{18}(CAT3B) + β_{19}(Fail) + β_{20}(Unknown) + β_{21}(E01) + β_{22}(E02) + β_{23}(E03) + β_{24}(E04) + β_{25}(E05+) + β_{26}(Unknown) + β_{27}(Dependents) + β_{28}(Marital Status) + β_{29}(Age) + β_{30}(Race/Ethnicity)(JROTC) + β_{31}(Race/Ethnicity)(Sex)

Promotion to E4 or E5 Model:

Ln(Pr(Promotion to E4 or E5 = 1)/1-Pr(Promotion to E4 or E5 = 1)) = β_0 + β_1(JROTC) + β_2(Sex) + β_3(American Indian) + β_4(Asian or Pacific Islander) + β_5(African-American) + β_6(Caucasian) + β_7(Hispanic) + β_8(Other) + β_9(Unknown) + β_{10}(Education below high school) + β_{11}(Currently in high school) + β_{12}(High school graduate or GED certificate) + β_{13}(Currently in college (Associate or Bachelor degree)) + β_{14}(Bachelor degree or postgraduate degree) + β_{15}(Unknown) + β_{16}(CAT1) +

β_{17}(CAT2) + β_{18}(CAT3A) + β_{19}(CAT3B) + β_{20}(Fail) + β_{21}(Unknown) + β_{22}(E01) + β_{23}(E02) + β_{24}(E03) + β_{25}(E04) + β_{26}(E05+) + β_{27}(Unknown) + β_{28}(Marital Status) + β_{29}(Race/Ethnicity)(Sex) + β_{30}(Sex)(AFQT Mental Group)

Reenlistment Model:

Ln(Pr(Reenlistment = 1)/1-Pr(Reenlistment = 1)) = β_0 + β_1(JROTC) + β_2(Sex) + β_3(American Indian) + β_4(Asian or Pacific Islander) + β_5(African-American) + β_6(Caucasian) + β_7(Hispanic) + β_8(Other) + β_9(Unknown) + β_{10}(Education below high school) + β_{11}(Currently in high school) + β_{12}(High school graduate or GED certificate) + β_{13}(Currently in college (Associate or Bachelor degree)) + β_{14}(Bachelor degree or postgraduate degree) + β_{15}(Unknown) + β_{16}(CAT1) + β_{17}(CAT2) + β_{18}(CAT3A) + β_{19}(CAT3B) + β_{20}(Fail) + β_{21}(Unknown) + β_{22}(E01) + β_{23}(E02) + β_{24}(E03) + β_{25}(E04) + β_{26}(E05+) + β_{27}(Unknown) + β_{28}(Marital Status) + β_{29}(Entry Pay Grade)(AFQT Mental Group)

Time to Attrite Model:

E[Time to Attrite] = β_0 + β_1(JROTC) + β_2(Sex) + β_3(American Indian) + β_4(Asian or Pacific Islander) + β_5(African-American) + β_6(Caucasian) + β_7(Hispanic) + β_8(Other) + β_9(Unknown) + β_{10}(Education below high school) + β_{11}(Currently in high school) + β_{12}(High school graduate or GED certificate) + β_{13}(Currently in college (Associate or Bachelor degree)) + β_{14}(Bachelor degree or postgraduate degree) + β_{15}(Unknown) + β_{16}(CAT1) + β_{17}(CAT2) + β_{18}(CAT3A) + β_{19}(CAT3B) + β_{20}(Fail) + β_{21}(Unknown) + β_{22}(E01) + β_{23}(E02) + β_{24}(E03) + β_{25}(E04) + β_{26}(E05+) + β_{27}(Unknown) + β_{28}(Dependents) + β_{29}(Marital Status) + β_{30}(Age) + β_{31}(Race/Ethnicity)(Sex)

Time to Promote Model:

E[Time to Promote] = β_0 + β_1(Sex) + β_2(American Indian) + β_3(Asian or Pacific Islander) + β_4(African-American) + β_5(Caucasian) + β_6(Hispanic) + β_7(Other) + β_8(Unknown) + β_9(Education below high school) + β_{10}(Currently in high school) + β_{11}(High school graduate or GED certificate) + β_{12}(Currently in college (Associate or Bachelor degree)) + β_{13}(Bachelor degree or postgraduate degree) + β_{14}(Unknown) + β_{15}(CAT1) + β_{16}(CAT2) + β_{17}(CAT3A) + β_{18}(CAT3B) + β_{19}(Fail) + β_{20}(Unknown)

$+\beta_{21}$(E01) + β_{22}(E02) + β_{23}(E03) + β_{24}(E04) + β_{25}(E05+) + β_{26}(Unknown) + β_{27}(Marital Status) + β_{28}(Race/Ethnicity)(Sex) + β_{29}(Education Level)(Age)

Of the above final models, only First-term Attrition and Time to Promote do not contain JROTC as a predictor variable. Therefore, JROTC is not significant in Attrition and Time to Promote.

The Beta coefficients (β_i) for the parameters of these five final models, along with each parameter's standard error and t-value, are included in Tables 15-19 in the Appendix. In the Time to Attrite and Time to Promote models, p-values are included because these models are linear regressions.

2. Cross-validation

As stated in Chapter III, cross-validation is necessary to test the final models and validate them. A regression model is fit to most of the data set. We then measure how well the model fits the rest of the data set by predicting values for the remaining subset. Table 14 below presents the results (average residual deviance/average residual sum of squares) of running the xval function on our five final models.

Table 14. Cross-validation of Additive Models and Final Models

ADDITIVE MODELS	Residual Deviance/RSS	**FINAL MODELS**	Residual Deviance/RSS
First-term Attrition	3.258	First-term Attrition	3.257
Promotion to E4 or E5	3.260	Promotion to E4 or E5	3.258
Reenlistment	3.484	Reenlistment	3.483
Time to Attrite	2.5833	Time to Attrite	2.5831
Time to Promote	1.578	Time to Promote	1.580

We compared the average residual deviance/average RSS of the base and final models for Attrition, Promotion, Reenlistment, Time to Attrite, and Time to Promote. The goal for each final model is to have a lower average RSS than its respective base model, which we found to be true in all but one model, which was the Time to Promote model. Therefore, the changes we made to base models, either by removing main effects or adding interactions, help portray relationships with the dependent response variables. The final models predict y_i values in our dependent variables well.

B. CONCLUSION

Each base model in our analysis was changed, some more than others, in order to arrive at the final models. The final models show what variables are significant to the models. In our First-term Attrition model, JROTC was removed from the model, while the interactions of Race/Ethnicity and JROTC and Race/Ethnicity and Sex were added. For our Promotion model, Age and Dependents were removed, while the interactions of Race/Ethnicity and Sex and Sex and AFQT Mental Group were added. Concerning our Reenlistment model, the variables of Age, Dependents, and Sex were all removed, while the interaction of Entry Pay Grade and AFQT Mental Group were added. In our Time to Attrite model, nothing was removed, while the interaction of Race/Ethnicity and Sex was added. Finally, for our Time to Promote model, the variables of JROTC, Age, and Dependents were taken out, while the interactions of Race/Ethnicity and Sex and Education and Age were added. It should be duly noted that the 50,290 service members (out of the original 308,367 observations) who left the Navy voluntarily or due to attrition in their first year were deleted from the comprehensive JROTC data set and thus influenced our final models and conclusions.

The goal of this thesis has been to analyze and measure the effects of JROTC on new U.S. Navy enlisted recruits' performance in the Fleet by observing Attrition, Promotion, Reenlistment, Time to Attrite, and Time to Promote during the first term of enlistment. All data was provided by the Defense Manpower Data Center (DMDC). The data set included all Navy recruits in accession FY1994-2000 who completed at least the first year of their first term. Our data analysis finds that JROTC has a suggestive, but not

definite, positive association with First-term Attrition and Time to Promote. Furthermore, JROTC has a definite significant positive association with Promotion to E4 or E5, Reenlistment, and Time to Attrite.

1. Recommendations and Future Studies

The JROTC program prepares high school students for the military life by introducing them to military training and ideology. This allows these students to adapt better to the military if they choose to enlist, giving them an advantage over Non-JROTC students. Therefore, it may be beneficial to the Navy to target JROTC high school students in their recruitment efforts.

This analysis suggests that JROTC participation has a positive association with performance during a service member's first term of enlistment. A more thorough study is needed which includes Navy recruits who leave the Navy in the first year of their enlistment. It is likely that the benefits of JROTC are felt more strongly in this first year. Then a next step should be to conduct a cost-benefit analysis of the JROTC program to determine whether money saved from lower attrition rates, higher promotion and reenlistment rates, and better times to attrite and promote exceeds the Navy's share of the cost of the JROTC program. This cost-benefit analysis could then provide the Navy with the necessary information to make better decisions on funding and possible expansion of the JROTC program in high schools across the nation.

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APPENDIX

Table 15. First-term Attrition Final Model Coefficients Table

FIRST-TERM ATTRITION FINAL MODEL (Logistic Regression Model)			
Parameters	**Coefficient ($\hat{\beta}_i$)**	**Standard Error**	**z-value**
(Intercept)	-0.011	0.073	-0.149
SEX1	-0.146	0.065	-2.243
RACE.ETH1B	-0.697	0.083	-8.403
RACE.ETH1C	-0.388	0.062	-6.203
RACE.ETH1D	0.033	0.060	0.550
RACE.ETH1E	-0.400	0.067	-5.951
RACE.ETH1X	-0.257	0.177	-1.451
RACE.ETH1Z	-0.450	0.221	-2.034
ED1<HS	-0.160	0.033	-4.781
ED1Curr	-0.820	0.083	-9.781
ED1HS	-0.769	0.030	-25.425
ED1C2	-0.370	0.039	-9.449
ED1Coll+	-0.826	0.051	-16.015
ED1Unk	-0.461	0.035	-13.005
MNTL.GRPCAT2	-0.069	0.021	-3.272
MNTL.GRPCAT3A	0.005	0.022	0.243
MNTL.GRPCAT3B	0.104	0.022	4.631
MNTL.GRPFail	0.258	0.146	1.760
MNTL.GRPUnk	0.277	0.038	7.151
PG1E02	0.016	0.010	1.552
PG1E03	-0.248	0.013	-18.500
PG1E04	-0.450	0.025	-17.795
PG1E05+	-1.262	0.069	-18.194
PG1Unk	-0.167	0.070	-2.373
DEPS1	0.068	0.012	5.711
MARIT1	0.045	0.023	1.987
AGE1	0.001	0.000	2.038
RACE.ETH1AJROTC	0.169	0.189	0.895
RACE.ETH1BJROTC	0.359	0.169	2.116
RACE.ETH1CJROTC	-0.011	0.045	-0.250
RACE.ETH1DJROTC	0.0627	0.038	1.645
RACE.ETH1EJROTC	-0.005	0.103	-0.054
RACE.ETH1XJROTC	0.021	0.512	0.041
RACE.ETH1ZJROTC	0.984	0.363	2.706
SEX1RACE.ETH1B	-0.088	0.091	-0.959

SEX1RACE.ETH1C	0.380	0.069	5.448
SEX1RACE.ETH1D	-0.071	0.067	-1.069
SEX1RACE.ETH1E	0.037	0.074	0.496
SEX1RACE.ETH1X	-0.042	0.197	-0.213
SEX1RACE.ETH1Z	0.169	0.237	0.714

Table 16. Promotion to E4 or E5 Final Model Coefficients Table

PROMOTION TO E4 OR E5 FINAL MODEL (Logistic Regression Model)			
Parameters	**Coefficient ($\hat{\beta}_i$)**	**Standard Error**	**z-value**
(Intercept)	-0.037	0.096	-0.383
JROTC	-0.322	0.027	-11.815
SEX1	0.137	0.098	1.392
RACE.ETH1B	0.298	0.078	3.802
RACE.ETH1C	0.018	0.062	0.292
RACE.ETH1D	-0.128	0.060	-2.105
RACE.ETH1E	0.091	0.066	1.381
RACE.ETH1X	0.080	0.170	0.474
RACE.ETH1Z	0.806	0.257	3.132
ED1<HS	0.170	0.034	4.983
ED1Curr	0.610	0.079	7.651
ED1HS	0.651	0.030	21.140
ED1C2	0.233	0.040	5.817
ED1Coll+	0.418	0.053	7.779
ED1Unk	0.118	0.036	3.251
MNTL.GRPCAT2	-0.194	0.071	-2.724
MNTL.GRPCAT3A	-0.669	0.071	-9.324
MNTL.GRPCAT3B	-1.024	0.072	-14.221
MNTL.GRPFail	-2.000	0.462	-4.326
MNTL.GRPUnk	-0.942	0.137	-6.844
PG1E02	0.576	0.009	58.465
PG1E03	1.155	0.013	84.925
PG1E04	14.348	7.488	1.916
PG1E05+	1.328	0.066	20.025
PG1Unk	0.871	0.068	12.702
MARIT1	-0.079	0.015	-5.197
SEX1RACE.ETH1B	0.092	0.086	1.061
SEX1RACE.ETH1C	-0.333	0.070	-4.751
SEX1RACE.ETH1D	0.123	0.068	1.809
SEX1RACE.ETH1E	0.062	0.074	0.841
SEX1RACE.ETH1X	0.002	0.190	0.013
SEX1RACE.ETH1Z	-0.823	0.274	-3.000

SEX1MNTL.GRPCAT2	-0.013	0.076	-0.174
SEX1MNTL.GRPCAT3A	0.145	0.076	1.907
SEX1MNTL.GRPCAT3B	0.212	0.076	2.766
SEX1MNTL.GRPFail	1.207	0.495	2.437
SEX1MNTL.GRPUnk	0.229	0.145	1.584

Table 17. Reenlistment Final Model Coefficients Table

REENLISTMENT FINAL MODEL (Logistic Regression Model)			
Parameters	**Coefficient ($\hat{\beta}_i$)**	**Standard Error**	**z-value**
(Intercept)	-0.494	0.066	-7.473
JROTC	-0.049	0.025	-1.965
RACE.ETH1B	0.667	0.031	21.316
RACE.ETH1C	0.2145	0.026	8.124
RACE.ETH1D	-0.075	0.025	-3.016
RACE.ETH1E	0.218	0.027	7.996
RACE.ETH1X	0.262	0.069	3.768
RACE.ETH1Z	0.188	0.072	2.584
ED1<HS	0.162	0.034	4.728
ED1Curr	0.629	0.076	8.252
ED1HS	0.519	0.030	16.768
ED1C2	0.214	0.039	5.460
ED1Coll+	0.416	0.047	8.790
ED1Unk	0.236	0.035	6.625
MNTL.GRPCAT2	-0.029	0.053	-0.553
MNTL.GRPCAT3A	-0.115	0.053	-2.145
MNTL.GRPCAT3B	-0.247	0.053	-4.623
MNTL.GRPFail	0.105	0.239	0.442
MNTL.GRPUnk	-0.642	0.145	-4.412
PG1E02	0.355	0.066	5.360
PG1E03	0.757	0.058	13.052
PG1E04	1.132	0.066	17.022
PG1E05+	1.350	0.249	5.422
PG1Unk	1.647	0.787	2.092
MARIT1	-0.102	0.013	-7.639
MNTL.GRPCAT2PG1E02	-0.085	0.068	-1.249
MNTL.GRPCAT3APG1E02	-0.286	0.068	-4.181
MNTL.GRPCAT3BPG1E02	-0.328	0.068	-4.805
MNTL.GRPFailPG1E02	-0.827	0.402	-2.054
MNTL.GRPUnkPG1E02	0.152	0.207	0.736
MNTL.GRPCAT2PG1E03	-0.158	0.060	-2.619
MNTL.GRPCAT3APG1E03	-0.391	0.062	-6.244

MNTL.GRPCAT3BPG1E03	-0.378	0.062	-6.061
MNTL.GRPFailPG1E03	-0.640	0.385	-1.663
MNTL.GRPUnkPG1E03	-0.221	0.160	-1.381
MNTL.GRPCAT2PG1E04	0.023	0.073	0.315
MNTL.GRPCAT3APG1E04	-0.426	0.101	-4.203
MNTL.GRPCAT3BPG1E04	-0.432	0.117	-3.687
MNTL.GRPFailPG1E04	-1.145	0.351	-3.256
MNTL.GRPUnkPG1E04	-0.261	0.155	-1.686
MNTL.GRPCAT2PG1E05+	0.139	0.286	0.487
MNTL.GRPCAT3APG1E05+	0.017	0.315	0.055
MNTL.GRPCAT3BPG1E05+	-0.491	0.355	-1.382
MNTL.GRPFailPG1E05+	-1.360	1.454	-0.935
MNTL.GRPUnkPG1E05+	0.413	0.289	1.427
MNTL.GRPCAT2PG1Unk	-1.725	0.799	-2.158
MNTL.GRPCAT3APG1Unk	-1.684	0.795	-2.116
MNTL.GRPCAT3BPG1Unk	-1.492	0.792	-1.883
MNTL.GRPFailPG1Unk	NA	NA	NA
MNTL.GRPUnkPG1Unk	-6.411	6.995	-0.916

Table 18. Time to Attrite Final Model Coefficients Table

TIME TO ATTRITE FINAL MODEL (Linear Regression Model)				
Parameters	**Coefficient ($\hat{\beta}_i$)**	**Standard Error**	**t-value**	**p-value**
(Intercept)	2.410	0.089	27.090	0.000
JROTC	-0.294	0.031	-9.257	0.000
SEX1	-0.189	0.079	-2.391	0.016
RACE.ETH1B	-0.075	0.093	-0.811	0.417
RACE.ETH1C	-0.029	0.075	-0.389	0.696
RACE.ETH1D	0.353	0.073	4.841	0.000
RACE.ETH1E	0.127	0.080	1.592	0.111
RACE.ETH1X	-0.081	0.207	-0.389	0.696
RACE.ETH1Z	1.310	0.240	5.458	0.000
ED1<HS	0.191	0.042	4.477	0.000
ED1Curr	0.237	0.096	2.447	0.014
ED1HS	0.365	0.038	9.477	0.000
ED1C2	0.193	0.049	3.934	0.000
ED1Coll+	0.358	0.058	6.081	0.000
ED1Unk	1.099	0.044	24.622	0.000
MNTL.GRPCAT2	0.040	0.023	1.693	0.090
MNTL.GRPCAT3A	0.062	0.025	2.450	0.014
MNTL.GRPCAT3B	-0.071	0.025	-2.781	0.005
MNTL.GRPFail	2.060	0.173	11.883	0.000

MNTL.GRPUnk	3.184	0.043	73.332	0.000
PG1E02	0.177	0.012	14.520	0.000
PG1E03	0.411	0.015	27.060	0.000
PG1E04	1.563	0.027	57.650	0.000
PG1E05+	0.916	0.063	14.386	0.000
PG1Unk	-0.054	0.081	-0.668	0.504
DEPS1	0.009	0.014	0.707	0.479
MARIT1	-0.197	0.026	-7.393	0.000
AGE1	0.004	0.000	7.186	0.000
SEX1RACE.ETH1B	-0.082	0.102	-0.806	0.420
SEX1RACE.ETH1C	0.175	0.083	2.100	0.035
SEX1RACE.ETH1D	0.016	0.081	0.208	0.834
SEX1RACE.ETH1E	0.080	0.088	0.903	0.366
SEX1RACE.ETH1X	0.133	0.229	0.582	0.559
SEX1RACE.ETH1Z	0.132	0.258	0.511	0.608

Table 19. Time to Promote Final Model Coefficients Table

TIME TO PROMOTE FINAL MODEL (Linear Regression Model)				
Parameters	**Coefficient ($\hat{\beta}_i$)**	**Standard Error**	**t-value**	**p-value**
(Intercept)	0.084	0.193	0.438	0.660
SEX1	0.138	0.048	2.861	0.004
RACE.ETH1B	0.272	0.057	4.788	0.000
RACE.ETH1C	0.036	0.045	0.792	0.428
RACE.ETH1D	-0.027	0.044	-0.609	0.542
RACE.ETH1E	0.126	0.048	2.575	0.010
RACE.ETH1X	0.083	0.126	0.659	0.509
RACE.ETH1Z	0.356	0.146	2.427	0.015
ED1<HS	1.187	0.190	6.236	0.000
ED1Curr	1.217	0.615	1.978	0.047
ED1HS	1.714	0.187	9.135	0.000
ED1C2	0.718	0.216	3.324	0.000
ED1Coll+	1.783	0.265	6.710	0.000
ED1Unk	1.347	0.188	7.152	0.000
MNTL.GRPCAT2	0.107	0.014	7.418	0.000
MNTL.GRPCAT3A	0.017	0.015	1.139	0.254
MNTL.GRPCAT3B	-0.178	0.015	-11.49	0.000
MNTL.GRPFail	-0.124	0.105	-1.175	0.240
MNTL.GRPUnk	-0.055	0.026	-2.098	0.035
PG1E02	0.160	0.007	21.587	0.000
PG1E03	0.139	0.009	15.432	0.000
PG1E04	-0.907	0.016	-54.825	0.000

PG1E05+	-1.070	0.038	-27.570	0.000
PG1Unk	0.395	0.050	7.902	0.000
MARIT1	-0.012	0.010	-1.237	0.215
SEX1RACE.ETH1B	0.061	0.062	0.975	0.329
SEX1RACE.ETH1C	-0.184	0.051	-3.609	0.000
SEX1RACE.ETH1D	0.059	0.049	1.200	0.230
SEX1RACE.ETH1E	0.053	0.054	0.986	0.324
SEX1RACE.ETH1X	0.038	0.140	0.275	0.782
SEX1RACE.ETH1Z	-0.347	0.158	-2.194	0.028
ED1NoneAGE1	0.059	0.009	6.538	0.000
ED1<HSAGE1	0.005	0.001	3.951	0.000
ED1CurrAGE1	0.024	0.031	0.772	0.439
ED1HSAGE1	-0.001	0.000	-1.997	0.045
ED1C2AGE1	0.031	0.004	6.771	0.000
ED1Coll+AGE1	-0.005	0.007	-0.717	0.473
ED1UnkAGE1	-0.000	0.000	-0.621	0.534

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